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SHORT COMMUNICATION

Evaluation of electrical nerve stimulation for epidural catheter positioning in the dog

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Abstract

Objective To evaluate the accuracy of epidural catheter placement at different levels of the spinal cord guided solely by electrical nerve stimulation and resultant segmental muscle contraction.

Study design Prospective, experiment.

Animals Six male and two female Beagles, age (1 ± 0.17 years) and weight (12.9 ± 1.1 kg).

Methods Animals were anesthetized with propofol and maintained with isoflurane. An insulated epidural needle was used to reach the lumbosacral epidural space. A Tsui epidural catheter was inserted and connected to a nerve stimulator (1.0 mA, 0.1 ms, 2 Hz) to assess positioning of the tip at specific spinal cord segments. The catheter was advanced to three different levels of the spinal cord: lumbar (L2-L5), thoracic (T5-T10) and cervical (C4-C6). Subcutaneous needles were previously placed at these spinal levels and the catheter was advanced to match the needle location, guided only by corresponding muscle contractions. Catheter position was verified by fluoroscopy. If catheter tip and needle were at the same vertebral body a score of zero was assigned. When catheter tip was cranial or caudal to the needle, positive or negative numbers, respectively, corresponding to the number of vertebrae between them, were assigned. The mean and standard deviation of the number of vertebrae between catheter tip and needle were calculated to assess accuracy. Results are given as mean ± SD.

Results The catheter position in relation to the needle was within 0.3 ± 2.0 vertebral bodies. Positive predictive values (PPV) were 57%, 83% and 71% for lumbar, thoracic and cervical regions respectively. Overall PPV was 70%. No significant difference in PPV among regions was found.

Conclusion and clinical relevance Placement of an epidural catheter at specific spinal levels using electrical nerve stimulation was feasible without radiographic assistance in dogs. Two vertebral bodies difference from the target site may be clinically acceptable when performing segmental epidural regional anesthesia.

Keywords epidural anesthesia, epidural catheter, nerve stimulation.

Introduction

Pain management is the cornerstone of wellbeing in patients undergoing surgery or after severe injury. The epidural route has been used in veterinary medicine for analgesia and anesthesia of the pelvic limbs and caudal abdomen for decades. The tech-

nique is often used in anesthetized patients to reduce the dose requirement of anesthetic agents and postoperative analgesics, and therefore their side effects (Skarda & Tranquilli 2007). In humans, epidural anesthesia and analgesia is routinely used for intra- and postoperative pain management of orthopedic and soft tissue surgeries and also for chronic pain processes (Kumar et al. 1991; Tsui et al. 2007; Forster et al. 2009). Pain scores are usually satisfactory with minimal side effects or patient complaint (Tsui et al. 2007).

The use of a technique in which the catheter tip is advanced to close proximity of the target site could minimize the local anesthetic dose required and still be effective. Traditionally, the tip location of an epidural catheter has been confirmed by radiographic imaging (Tsui et al. 2004). In the past decade, nerve stimulation of the epidural catheter during advancement and observation of the resulting contraction of muscles innervated by the corresponding spinal segment have been used to guide catheter placement in humans, without the need for radiography (Tsui et al. 1998, 2007; Ozawa et al. 2002). The goals of this study were to evaluate the feasibility and accuracy of nerve stimulation and resultant muscular contraction to guide epidural catheter placement at different levels of the spinal cord in dogs.

Material and methods

This study was approved by the Institutional Animal Care and Use Committee of Michigan State University, AUF: 05/08-076-00. Six male and two female, healthy, adult, purpose bred Beagle dogs were used in this study. Mean ± SD age and weight were 1 ± 0.2 years and 12.9 ± 1.1 kg, respectively. Food, but not water, was withheld for 12 hours before initiation of the experiment. A 20-gauge catheter was placed in either cephalic vein of the animals. Anesthesia was induced with propofol (1–5 mg kg^{-1}, IV) administered to effect, followed by intubation of the trachea. Dogs were connected to a circle breathing system and maintained on 1.5% isoflurane in oxygen and allowed to breathe spontaneously. Cardiovascular (ABP and HR) and respiratory ($P_E'CO_2$ and f_R) parameters were monitored (Powerlab PL-3516; AD instruments, CO) during catheter placement, nerve stimulation and fluoroscopy. No fluids were administered during the procedure as animals were participating in another study thereafter.

Animals were placed in sternal recumbency and the lumbosacral region was clipped and aseptically prepared for the placement of an epidural catheter (Stimulong Sono [Tsui set]; Pajunk Medical Systems L.P., GA, USA). An 18-gauge Tuohy needle was placed in the lumbosacral epidural space and confirmed with a hanging-drop technique. The epidural catheter was connected to a nerve stimulator (Stimuplex HNS12; B. Braun Medical, PA, USA), with a current of 1 mA, frequency of 2 Hz and pulse width of 0.1 ms, and threaded through the epidural needle to cause muscle contraction of the stimulated region. The ground electrode was placed at the right side at the level of the lumbosacral area. Contractions of a segmental group of dorsolateral muscles were seen during nerve stimulation. These muscle contractions were related to the position of the catheter tip and moved cranially with its cranial advancement. In order to assess accuracy of muscle contraction in predicting catheter tip position, hypodermic needles (2.5 cm, 20-gauge) were randomly placed laterally, at three different locations, along the level of the transverse processes of the spinal vertebrae in all dogs: cervical (C4-C6), thoracic (T5-T10) and lumbar (L2-L5) prior to catheter advancement. The epidural catheter was advanced until typical muscular contraction was noted at each of the hypodermic needle locations. The three regions were stimulated in the same order from lumbar to cervical in all dogs. Time to position the catheter was limited to no more than 5 minutes, at which time the procedure was aborted. The position of the tip of the catheter with respect to the hypodermic needles was then assessed by dorsoventral fluoroscopy. Animals were then allocated to another study and subsequently euthanized.

To quantify the accuracy of catheter tip location relative to the needle position, a number was derived based upon the final placement site of the tip of the catheter relative to the desired position/target (needle). If the catheter tip reached the desired vertebral level (visualized fluoroscopically), a zero was assigned to this data point. If the catheter tip was determined to be placed caudal to the desired vertebral level, a negative whole number was assigned based upon how many vertebral bodies short the catheter tip was determined to be from the desired target. Finally, if the catheter tip was passed beyond (cranial) the desired position a positive whole number was assigned based upon how many vertebral bodies beyond the target the catheter tip resided. The mean and SD of the distance between catheter